

## Description

The P9225-R-EVK Evaluation Kit demonstrates the functionality, features, and performances of the P9225-R 5W Wireless Power Receiver (Rx). The kit includes the P9225-R Mass-Market (MM) EV Board (EVB). The P9225-R converts AC voltage from a coil into a programmable DC voltage used by the load. The P9225-R has integrated protection for itself and the load from being damaged in some fault events including over-current, over-voltage, and over-temperature during power transfer. It also integrates an I2C communication interface and provides an interrupt pin ( $\overline{\text{INT}}$ ) for an external application processor (AP). The AP can read internal registers via I2C and read the interrupt pin to determine the P9225-R status. P9225-R can automatically detect the Tx and determine whether to operate in WPC or PMA protocol on startup. If in WPC protocol, the P9225-R can be programmed as needed for foreign object detection (FOD).

The P9225-R-EVK demonstrates a high-efficiency, turnkey reference design, and it is supported by comprehensive online digital resources to significantly expedite design-in efforts and enable rapid prototyping while minimizing the bill of materials (BOM). The total active printed circuit board (PCB) area is optimized to 40mm × 16mm.

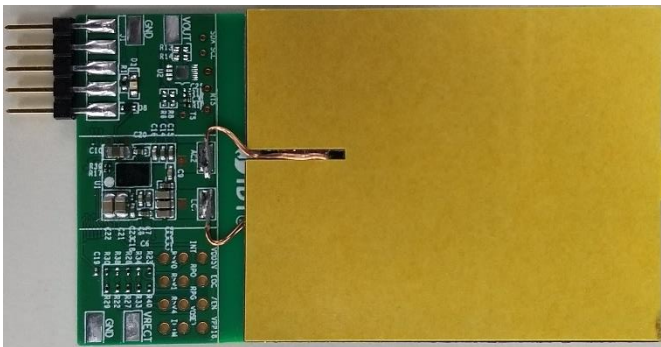
## Features

- WPC-1.2.4 compliant; PMA SR1 compatible
- Support for up to 5W Baseline Power Profile (BPP) power transfer
- Tx-Rx overall efficiency up to 82% (with the P9038-R-EVK, which is sold separately)
- 5V output voltage; also can be programmed in the range of 4.5V to 5.5V in 0.1V steps
- On-chip over-temperature protection
- Dedicated pin for remote temperature monitor
- Board includes an LED indicator for status monitor
- I2C interface and  $\overline{\text{INT}}$  pin for communication with AP
- Programmability for FOD tuning

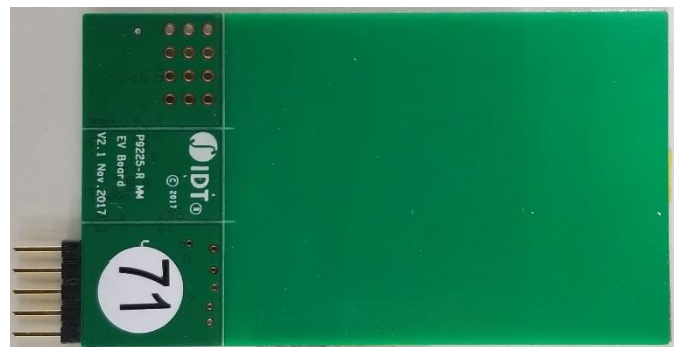
## Kit Contents

- P9225-R Mass-Market (MM) EV Board (EVB) including the coil assembly”

## P9225-R-EVK MM EV Board

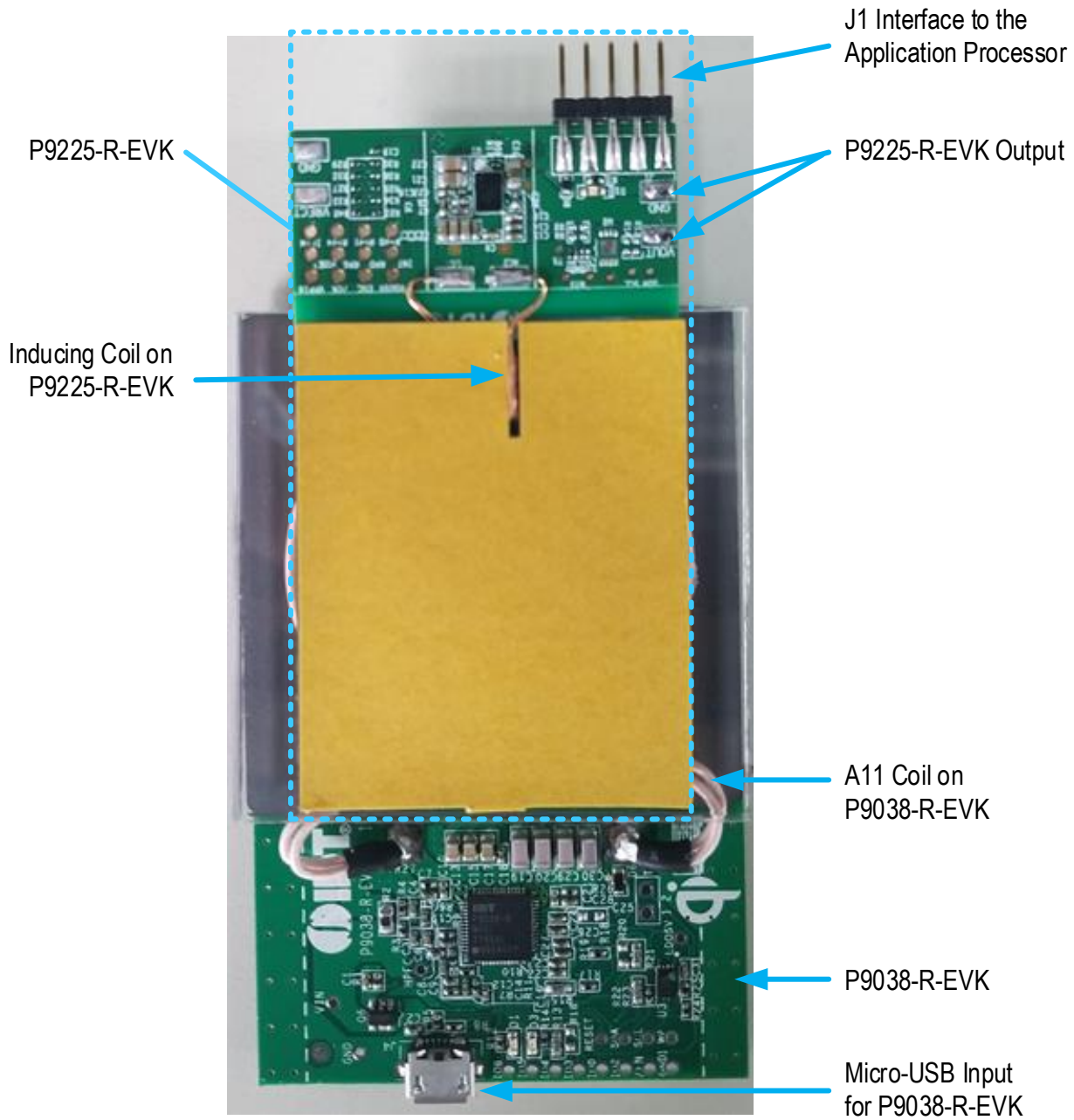


Top View



Bottom View

## Power Transfer with the P9225-R-EVK on the P9038-R-EVK



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**Restrictions in Use**

IDT's P9225-R-EVK is designed for evaluation purpose only. It must not be used for module or mass production purposes.

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# 1. Setup

## 1.1 Required or Recommended User Equipment

The following additional lab equipment is required for using the kit:

- P9038-R Transmitter Evaluation Board or any WPC-1.2.4 or PMA SR1 compliant transmitter.
- 5V DC power source or adapter that supports a type-C socket.

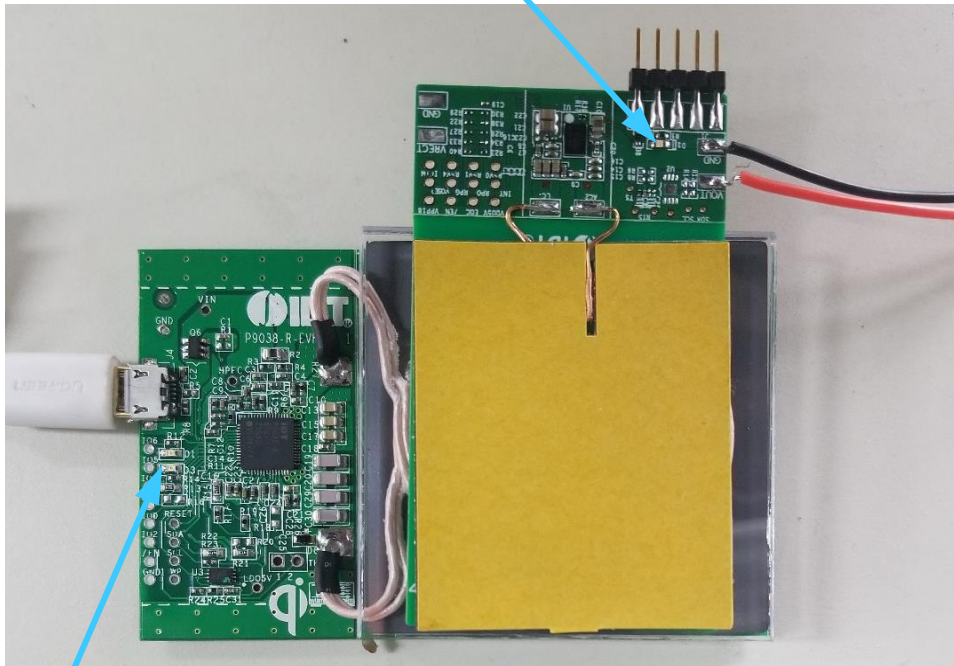
## 1.2 Kit Hardware Connections

Follow these procedures to set up the kit as shown in Figure 1.

1. Solder wires to the VOUT and GND test points on the P9225-R MM EV Board to allow measuring the output voltage or connect to load.
2. Set up the P9038-R Evaluation Board (or other transmitter board) according to the board's user manual and apply power.
3. Place the P9225-R MM EV Board at center on the transmitter coil surface with the yellow coil back facing upwards. P9225-R will detect which protocol the transmitter board uses.
4. Verify that the green LEDs on both kits are illuminated, which indicates that power transfer has been established.

**Figure 1. Evaluation Kit Connections**

Green D1 LED on P9225-R-EVK indicates that the wireless connection has been made



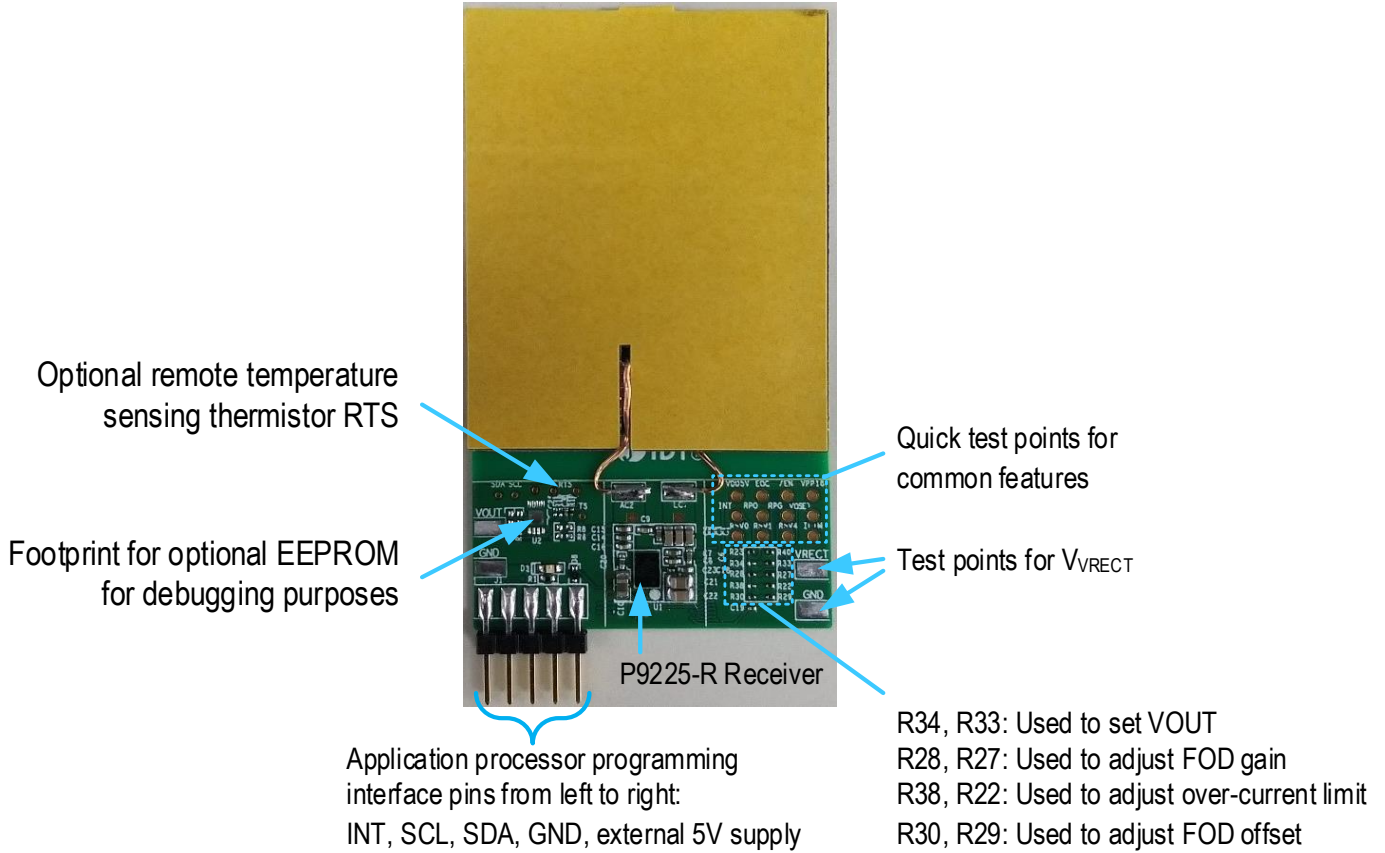
Solder wire leads to GND and VOUT test points to allow measuring VOUT or to apply load

Green D3 LED on P9038-R-EVK indicates that the wireless connection has been made

## 2. Usage Guide

### 2.1 Overview of the P9225-R EVK

Figure 2. P9225-R-EVK Features



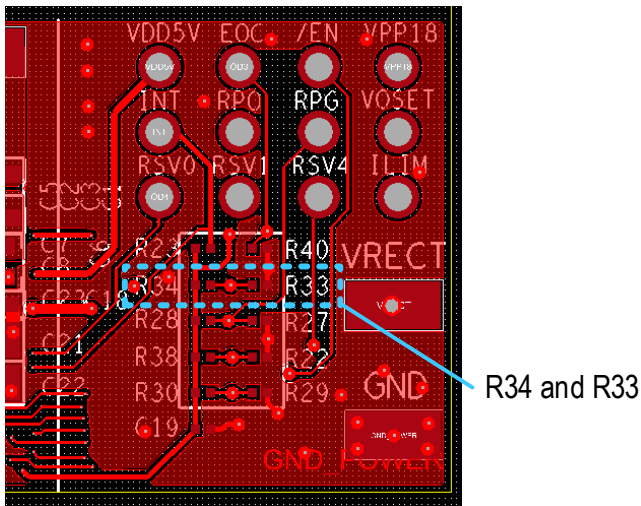
## 2.2 VOUT Programming

The P9225-R output voltage can be set to 4.5V through 5.5V in steps of 0.1V by changing the R34 or R33 resistor values; see Table 1. The default output voltage is set to 5V on the P9225-R-EVK as indicated by bold font in Table 1.

**Table 1. Setting the Output Voltage**

| R34         | R33         | V <sub>OUT</sub> |
|-------------|-------------|------------------|
| 10kΩ        | Open        | 4.5V             |
| 10kΩ        | 49.9kΩ      | 4.6V             |
| 10kΩ        | 34kΩ        | 4.7V             |
| 10kΩ        | 20kΩ        | 4.8V             |
| 10kΩ        | 14.7kΩ      | 4.9V             |
| <b>Open</b> | <b>10kΩ</b> | <b>5.0V</b>      |
| 10kΩ        | 10kΩ        | 5.1V             |
| 14.7kΩ      | 10kΩ        | 5.2V             |
| 20kΩ        | 10kΩ        | 5.3V             |
| 34kΩ        | 10kΩ        | 5.4V             |
| 49.9kΩ      | 10kΩ        | 5.5V             |

**Figure 3. R34 and R33 Location on the PCB**



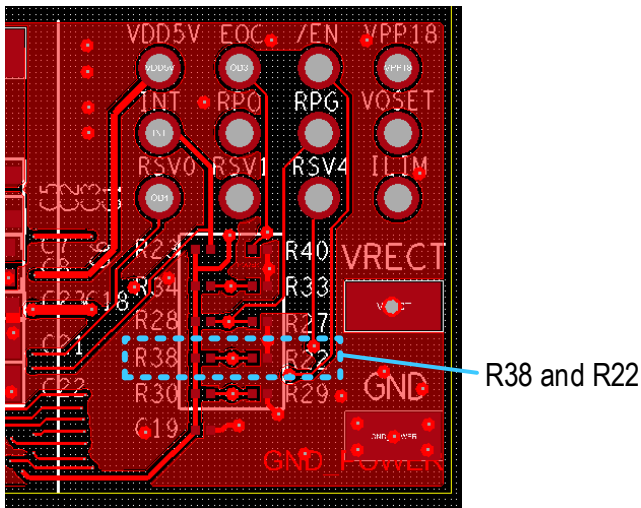
### 2.3 Over Current Limit Programming

The P9225-R has a programmable current limit for protecting the device in the event of an over-current or short-circuit fault condition. If the output current exceeds the programmed threshold, the P9225-R will limit the load current by reducing the output voltage. Recommendation: Set the current limit to 130% of the maximum output current by setting the voltage on the ILIM pin as shown in Table 2 by adjusting R22 while keeping R38 as 10kΩ, which is connected to the 1.8V supply. The default value for the over-current limit is set to 1.2A on the R9225-R-EVK as indicated by bold font.

**Table 2. Setting the Over-Current Limit**

| R38         | R22         | ILIM Setting for Maximum I <sub>OUT</sub> |
|-------------|-------------|---|
| 10kΩ        | 47kΩ        | 0.8A                                      |
| 10kΩ        | 22kΩ        | 0.9A                                      |
| 10kΩ        | Open        | 1.0A                                      |
| 10kΩ        | 10kΩ        | 1.1A                                      |
| <b>Open</b> | <b>10kΩ</b> | <b>1.2A</b>                               |

**Figure 4. R38 and R22 Location on the PCB**





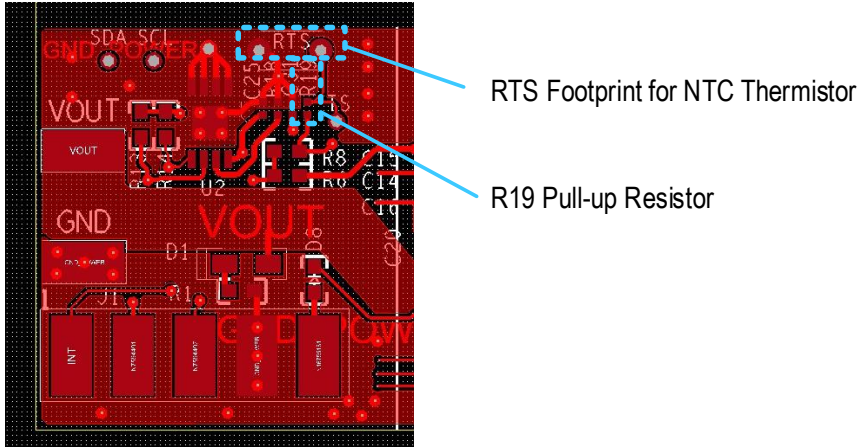
## 2.4 Remote Temperature Sensing Thermistor

The P9225-R includes the TS input pin for optional temperature sensing via an external NTC thermistor, which can be used to monitor a remote temperature, such as for a coil or a battery charger. The over-temperature shutdown is triggered if the voltage on the TS pin is lower than 0.6V. The TS pin voltage can be calculated by Equation 1. Note that the NTC thermistor (RTS) is not populated on the R9225-R-EVK.

$$V_{TS} = V_{VDD18} \times \frac{NTC}{NTC + R19} \tag{Equation 1}$$

Where NTC is the thermistor’s resistance and R19 is the pull-up resistor connected to the 1.8V supply voltage on the P9225-R-EVK.

**Figure 5. Location for R19 and Connecting Pads for the NTC Thermistor**

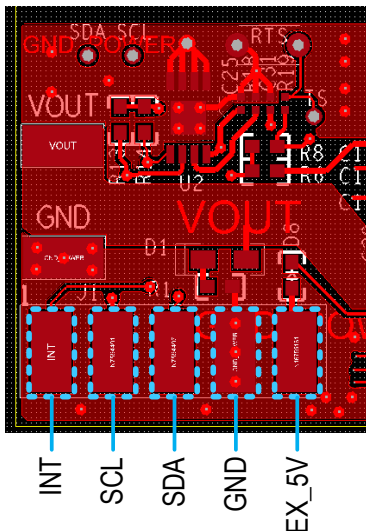


## 2.5 Communication Interface

P9225-R features an I2C interface circuit and an  $\overline{\text{INT}}$  pin to communicate with an external AP. The AP can read the  $\overline{\text{INT}}$  pin status or internal registers to determine what action is required.

The  $\overline{\text{INT}}$  pin should be pulled up on the AP side to the proper voltage level. No pull-up resistor is included on the P9225-R-EVK. For further details, contact IDT Tech Support: [www.IDT.com/go/support](http://www.IDT.com/go/support).

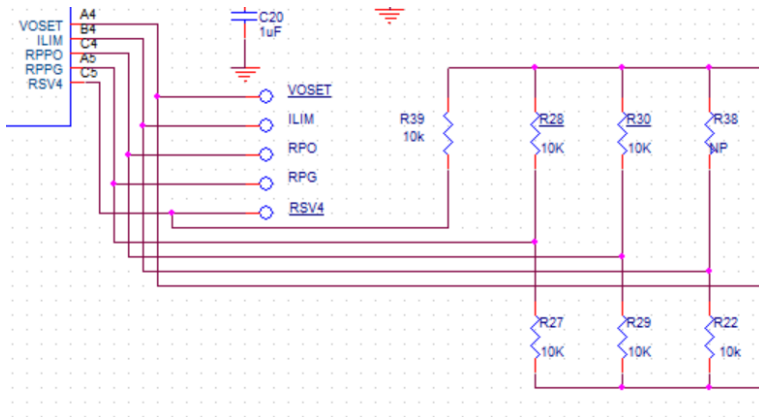
**Figure 6. Communication Port Pins**



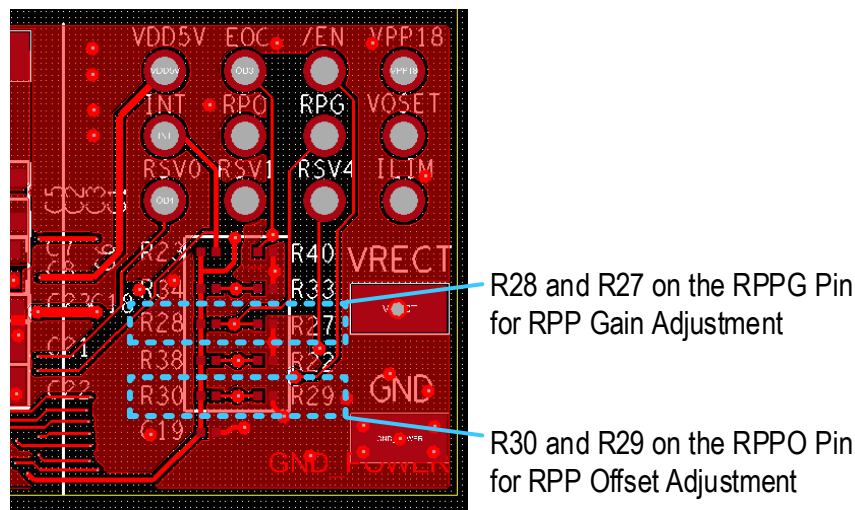
## 2.6 Foreign Object Detection (FOD) Tuning

Refer to the P9225-R Datasheet and the datasheet for the transmitter for a full explanation of foreign object detection. The transmitter uses the value sent by the P9225-R in the Received Power Packet (RPP) to determine whether a foreign object has been detected. The RPPG and RPPO pins on the P9225-R allow adjusting the RPP value to adapt the P9225 for various applications. The voltage on the RPPG pin determines the gain adjustment of the RPP value, which can be set by the values of R27 and R28 (see Figure 7). The voltage on the RPPO pin determines the offset adjustment of the RPP value, which can be set by the values of R29 and R30.

**Figure 7. RPPG and RPPO Connections**



**Figure 8. Locations of R27, R28, R29, and R30 on the PCB**



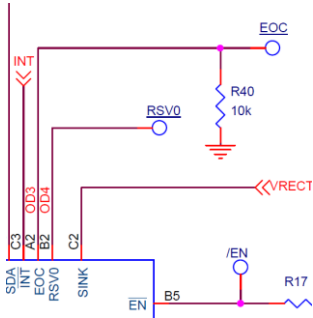
The P9225-R calculates the original received power by multiplying the voltage on the VRECT pin by the coil current, and then it performs initial calibrations to obtain the middle product  $P_{CAL}$ . Then the RPP value is computed using Equation 2:

$$RPP = RPPG * P_{CAL} + RPPO \tag{Equation 2}$$

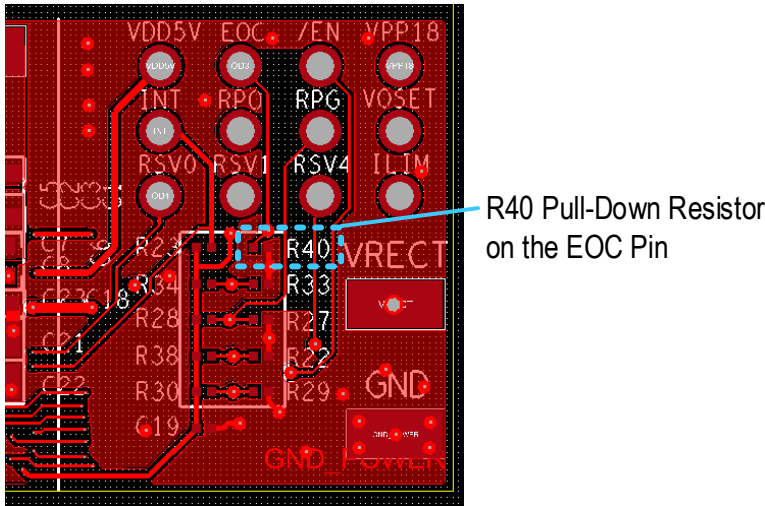
## 2.7 End-of-Charge (EOC)

When the voltage on the EOC pin is >1.4V, the P9225-R sends an End Power Transfer (EPT) packet (charge complete) to the transmitter, which then terminates the power transfer. The EOC pin is by default pulled to GND through R40.

**Figure 9. Connection for the EOC Pin**



**Figure 10. EOC Test Point on Board**



R40 Pull-Down Resistor on the EOC Pin

## 2.8 Receiving Coil

The following coil is recommended with the P9225-R receiver for 5W applications for optimum performance. The recommended vendor has been tested and verified. This coil is used for L1 in the P9225-R-EVK.

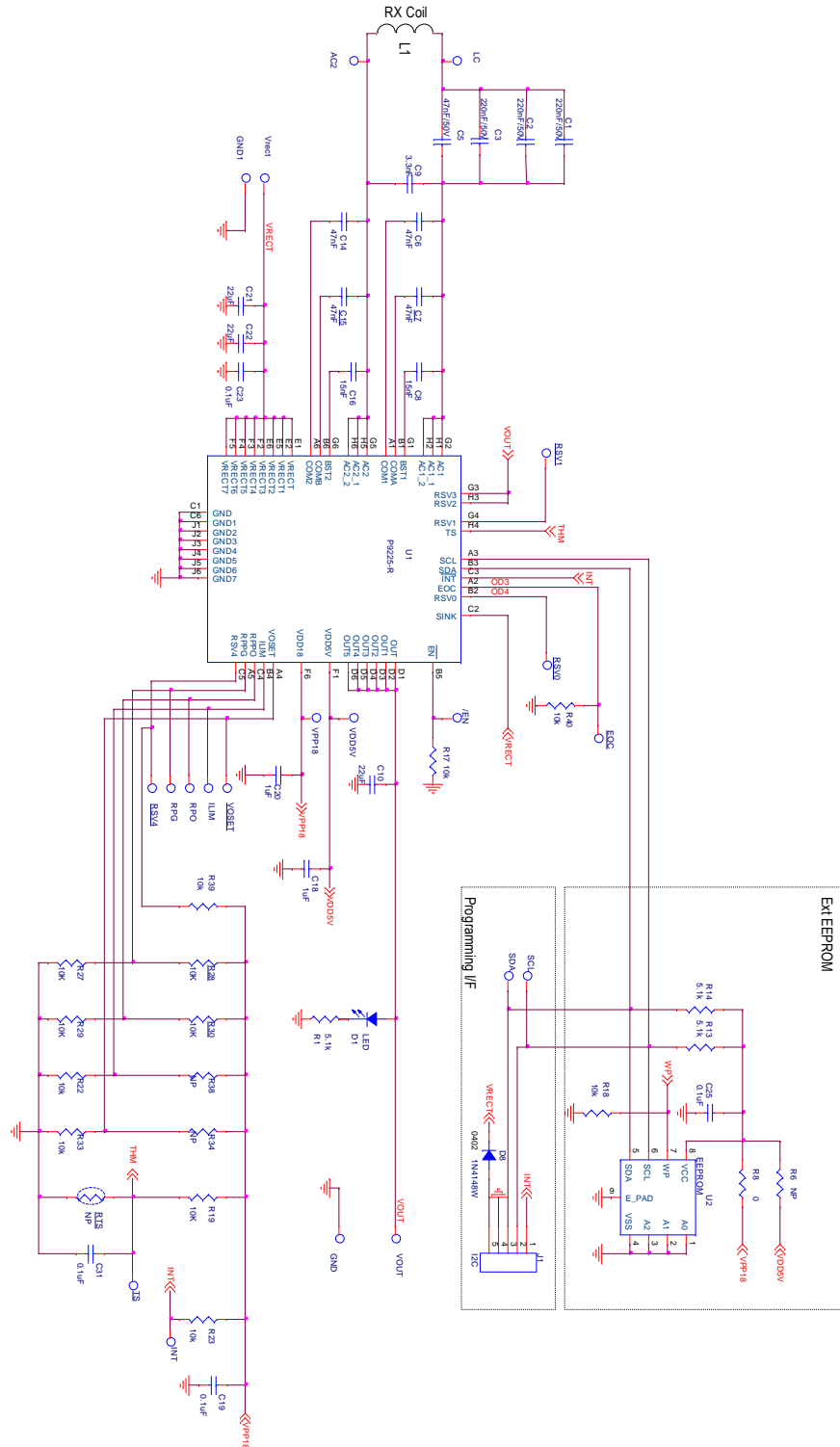
**Table 3. Coil Information**

| Output Power | Vendor  | Part Number          | Inductance at 100kHz | DCR at 20°C |
|--------------|---------|----------------------|----------------------|-------------|
| 5W           | Sunlord | SWA50R40H09C01BMDIDD | 8.3μH±10%            | 150mΩ ±20%  |

### 3. Hardware Information

#### 3.1 Schematic for P9225-R MM EV Board

Figure 11. Evaluation Board Schematic



### 3.2 Bill of Materials (BOM)

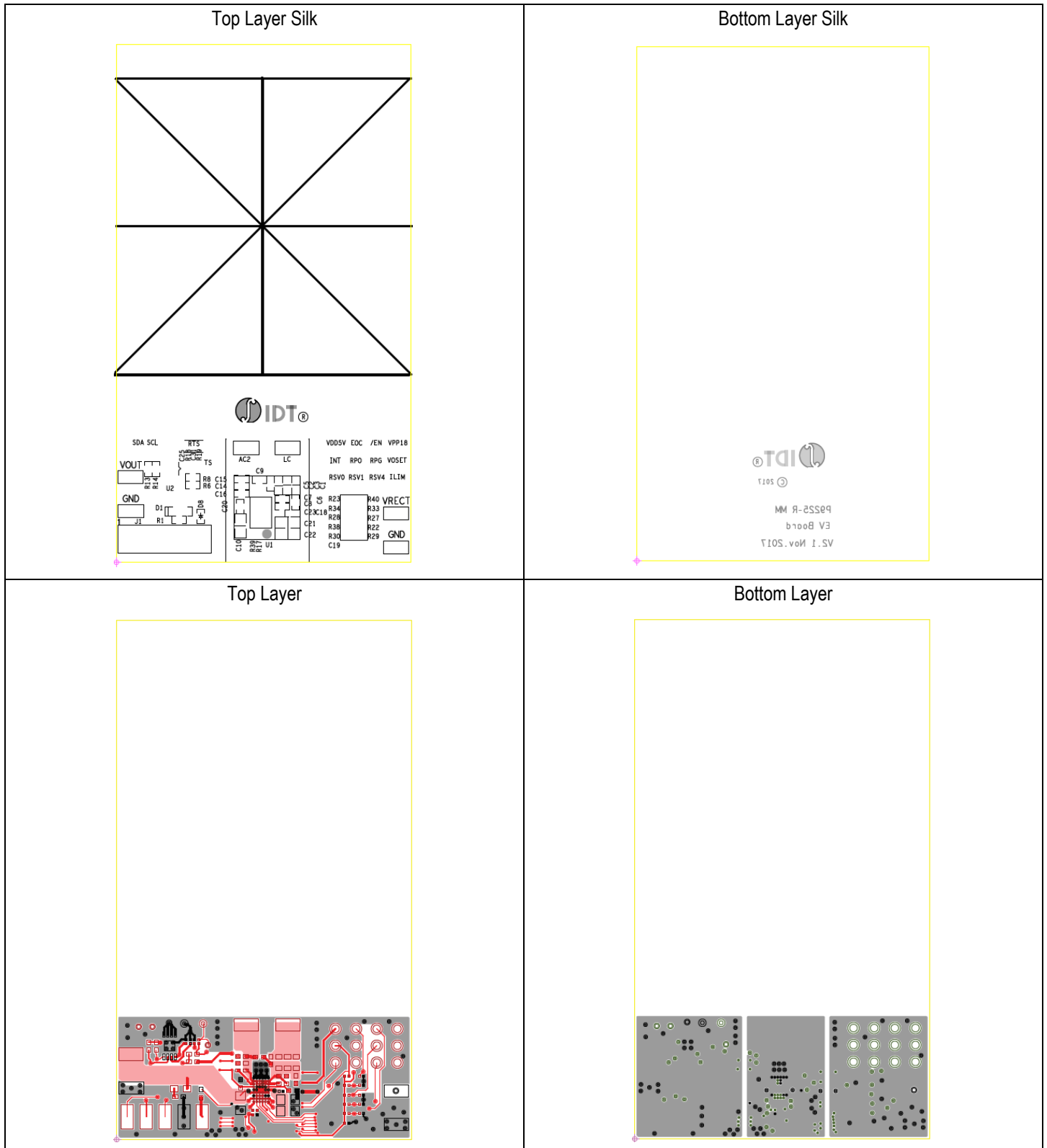
**Table 4. P9225-R MM EV Board BOM**

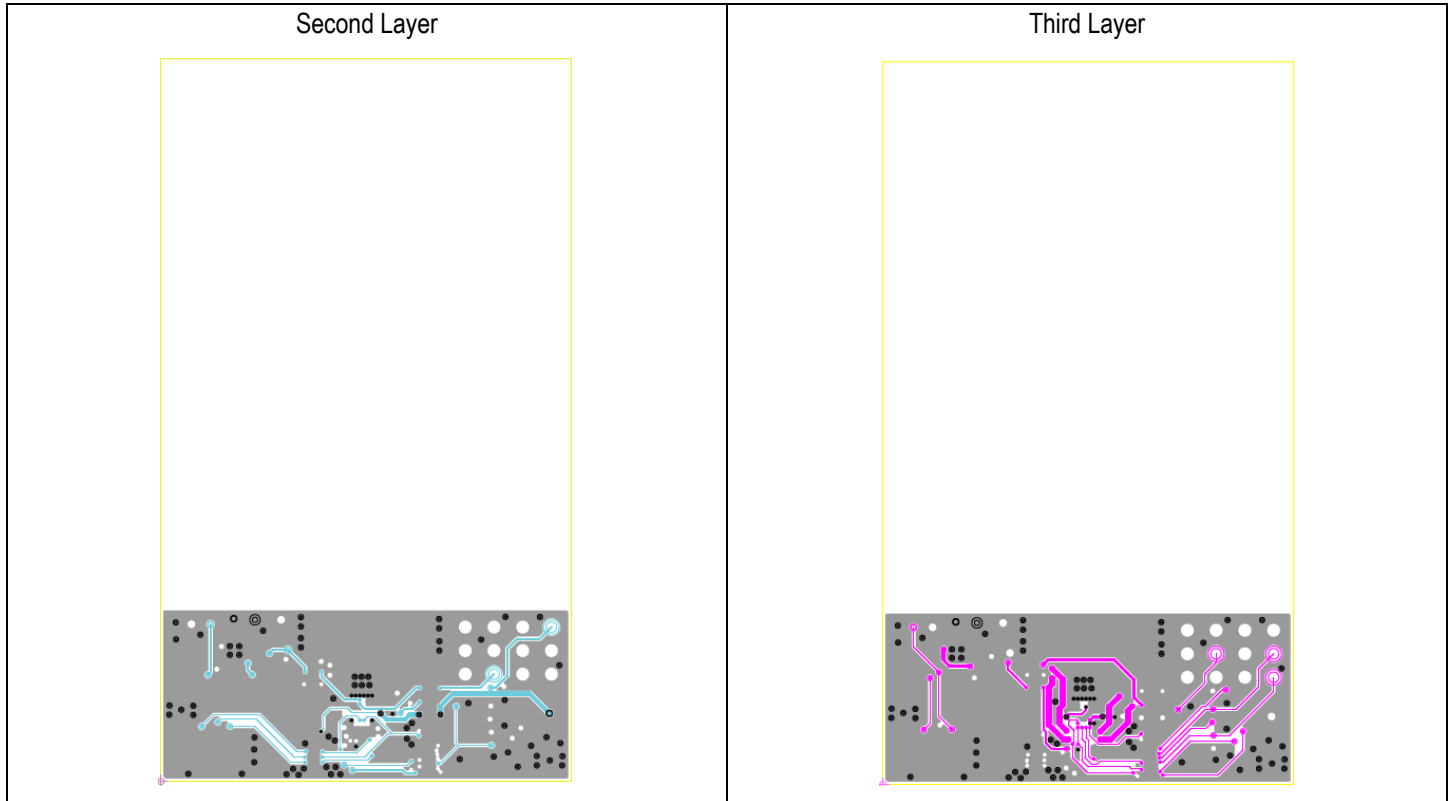
Note: See Table 3 for the details for L1.

| Reference   | Quantity | Value         | Description                        | Part Number        | PCB Footprint |
|---|----------|---------------|------------------------------------|--------------------|---------------|
| C1, C2, C3  | 3        | 220nF         | CAP CER 0.22 $\mu$ F 50V X7R 0603  | GRM188R71H224KAC4D | 0603          |
| C5  | 1        | 47nF          | CAP CER 0.047 $\mu$ F 50V X7R 0402 | GRM155R71H473KE14D | 0402          |
| C6, C7, C14, C15                                      | 4        | 47nF          | CAP CER 0.047 $\mu$ F 50V X7R 0402 | GRM155R71H473KE14D | 0402          |
| C8, C16   | 2        | 15nF          | CAP CER 0.015 $\mu$ F 50V X7R 0402 | GRM155R71H153KA12J | 0402          |
| C9  | 1        | 3.3nF         | CAP CER 3300PF 50V X7R 0402        | GRM155R71H332KA01D | 0402          |
| C10   | 1        | 22 $\mu$ F    | CAP CER 22 $\mu$ F 16V X5R 0805    | CL21A226MOCLRNC    | 0805          |
| C18, C20  | 2        | 1 $\mu$ F     | CAP CER 1 $\mu$ F 10V X5R 0402     | GRM155R61A105KE15D | 0402          |
| C19, C31  | 2        | 0.1 $\mu$ F   | CAP CER 0.1 $\mu$ F 10V X5R 0201   | GRM033R61A104ME15D | 0201          |
| C25   | 0        | NP            |                                    |                    |               |
| C21, C22  | 2        | 22 $\mu$ F    | CAP CER 22 $\mu$ F 25V X5R 0805    | CL21A226MAQNNNE    | 0805          |
| C23   | 1        | 0.1 $\mu$ F   | CAP CER 0.1 $\mu$ F 25V X5R 0201   | GRM033R61E104KE14D | 0201          |
| D1  | 1        | LED           | LED GREEN CLEAR 0603 SMD           | 150 060 GS7 500 0  | 0603          |
| D8  | 1        | 1N4148W       | DFN 150mA 75V Sm Sgnl Switching    | CDSQR4148          | 0402          |
| J1  | 1        | I2C           | HEADER_1X5_0P1PITCH60P42D          | 68002-205HLF       | DI            |
| RTS   | 0        | NP            |                                    |                    | DI            |
| R1  | 1        | 5.1k $\Omega$ | RES SMD 5.1K OHM 5% 1/16W 0402     | MCR01MRTJ512       | 0402          |
| R6,R8,R13, R14  | 0        | NP            |                                    |                    | 0402          |
| R17, R23, R39, R40, R19, R22, R27, R28, R29, R30, R33 | 11       | 10k $\Omega$  | RES SMD 10k $\Omega$ 5% 1/20W 0201 | ERJ-1GEJ103C       | 0201          |
| R18, R34, R38   | 0        | NP            |                                    |                    | 0201          |
| U1  | 1        | P9225-R       | MP Wireless Power Receiver         | P9225-R            | 52-WLCSP      |
| U2  | 0        | NP            |                                    |                    | TDFN08        |

### 3.3 Board Layout

Figure 12. Evaluation Board Layout





#### 4. Ordering Information

| Orderable Part Number | Description                        |
|-----------------------|------------------------------------|
| P9225-R-EVK           | P9225-R Mass-Market Evaluation Kit |

## 5. Revision History

| Revision Date  | Description of Change |
|----------------|-----------------------|
| April 24, 2018 | Initial release.      |



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